Appendix D

Stream Fluming Procedures

STREAM FLUMING PROCEDURES

During construction of Northwest's Everett Delta Lateral Project various local, state and federal permits will require that flowing streams with coldwater fisheries be crossed utilizing a "dry crossing" technique. Dry crossings can be achieved utilizing three primary techniques: 1) boring or drilling; 2) fluming; or 3) dam and pump. The Everett Delta Lateral Project will use drilling and fluming to cross flowing streams with coldwater fisheries. Dam and pump will not be utilized. The purpose of this appendix is to outline the techniques that will be utilized to flume stream crossings during construction of the project. These guidelines are subject to change based on permits issued by regulatory agencies. If requested, Northwest can demonstrate fluming techniques for the regulatory agencies.

1.0 Purpose of Flumed Stream Crossings

The primary purpose of fluming a stream is to assure that in-stream construction activities comply with water quality standards for turbidity that have been established by the state to protect aquatic life and other beneficial uses. Overall, a properly installed and maintained flume can be very effective in reducing turbidity during in-stream construction. In most cases, detectable increases in turbidity are limited to only the short duration when the flume is installed and when the flume is removed from the streambed.

However, simply installing a flume is no guarantee that compliance with water quality standards will occur. Flumes require constant monitoring and frequent repair during the entire crossing period to control leaks which can quickly undermine the integrity of the flume structure and result in water quality degradation. Adequate pumps play an integral role in a successful flumed crossing.

2.0 Where Flumes Will Be Installed

Any minor or intermediate (less than 100 feet in width) waterbody with water in the streambed at the time of construction, which has a coldwater fishery as defined by the Washington Department of Fish and Wildlife (WDFW), will be flumed. The Snohomish River and Ebey, Union and Steamboat sloughs will be drilled. A list of streams where fluming may be utilized is provided in Table 4 of this JARPA application (under "TABLES" tab).

3.0 General Layout of a Typical Flumed Stream Crossing

Figure 1 shows a plan view of a typical flumed stream crossing. The primary components of a flumed crossing include:

- flume pipe or multiple flume pipes;
- sandbag/plastic dams and/or clean gravel fill temporary equipment crossing bridge;
- spoil storage and staging areas;
- pumps and pump containment structure (s);
- dewater structure(s);
- erosion control structures; and
- spill containment and cleanup materials.

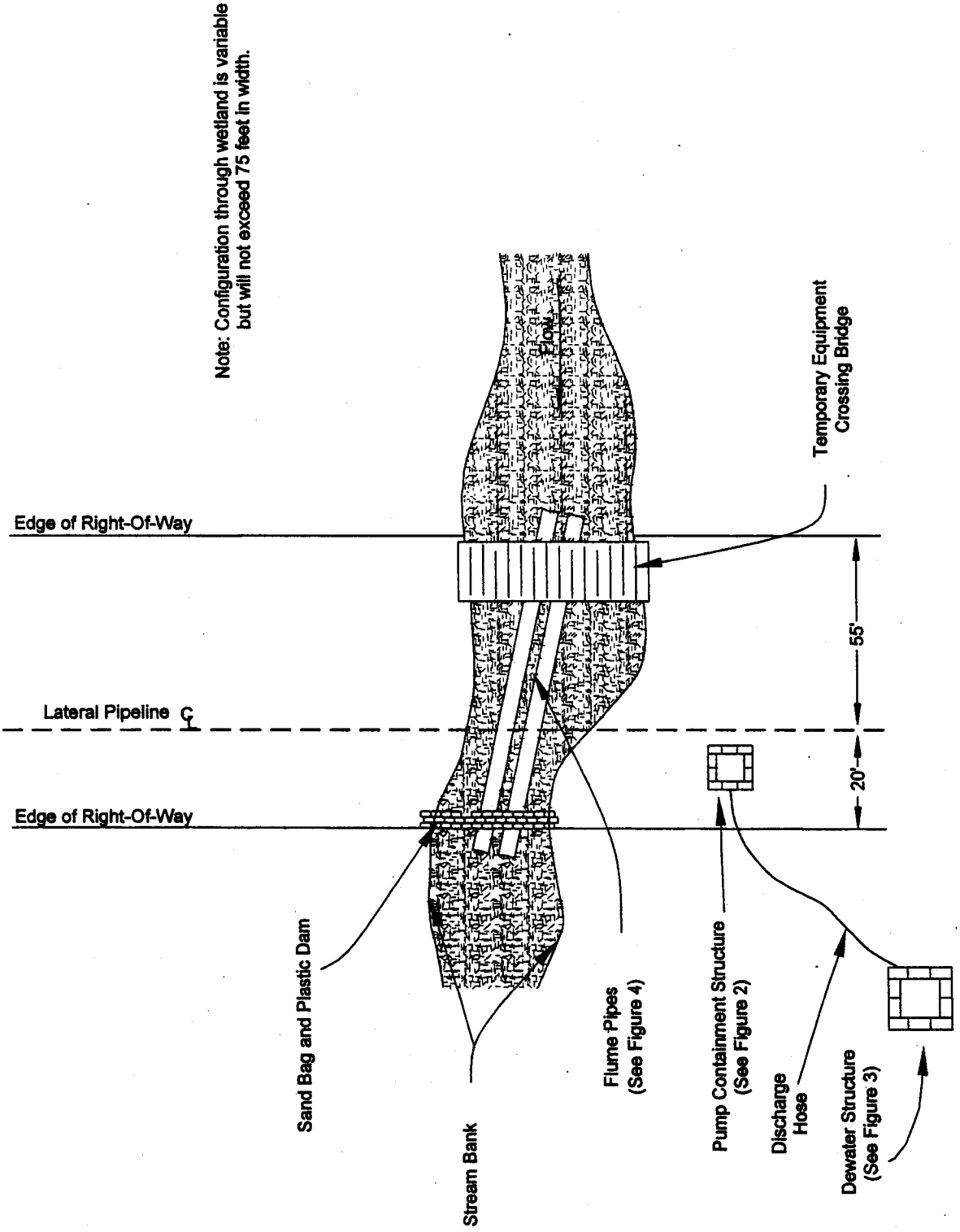


FIGURE 1
PLAN VIEW OF TYPICAL FLUMED STREAM CROSSING

A single or multiple flume pipe(s) are used to temporarily convey the stream flow over the construction area, thereby reducing the introduction of sediments into the water column during ditching and backfilling. The sandbag/plastic dams (or clean gravel temporary equipment crossing bridge) are used to support and seal the ends of the flume pipe(s) and to direct stream flow into the flume pipe and over the construction area. These structures are also utilized to prevent downstream water from flowing upstream into the construction area. They also serve to contain water that infiltrates into the construction area before it can be removed by the pumps and discharged to an upland area. Finally, the downstream structure serves to contain turbid water, which rises quickly in the construction area during backfilling of the trench.

All waterbodies with water in the streambed at the time of construction must have an equipment crossing bridge. In many cases, the contractor may decide to install a gravel temporary equipment crossing bridge to allow equipment to move across the stream. Only clean, pre-washed gravel will be used for this purpose. The clean gravel bridge can be utilized as either the upstream or downstream dam for the flume. However, the upstream and downstream faces of the gravel bridge must be lined with plastic to prevent water from flowing into or out of the construction area.

The temporary spoil storage area is where spoil trenched from the streambed will be stored until backfilling is completed. These temporary extra work areas are identified on the Environmental Alignment Sheets. FERC Procedures prohibit the location of staging areas or additional right-of-way within 50 feet of the stream banks or edge of adjacent wetlands. Trench spoil must be placed at least 10 feet away from stream banks at all flowing stream crossings. In addition, these areas must be enclosed with silt fence and/or straw bales to prevent runoff of the spoil into the stream.

Adequate pumps are essential for the successful completion of flumed stream crossings. During several phases of the crossing process, it will be necessary to quickly remove large quantities of water from the construction area to prevent overflow or leakage of the sandbag/plastic dams or the temporary equipment crossing bridge. Experience has demonstrated that the only effective means of quickly removing water from the construction area is by utilizing well-maintained pumps with adequate pumping rates. In addition, backup pumps will be located on-site, hooked up and maintained as fully operational during the entire crossing process. Backup pumps will be tested prior to the start of construction. Pumps will be located in a spill containment structure that is designed to fully contain any spills of fuel or oil (see Figure 2).

Dewater structures (see Figure 3) will be utilized to reduce the velocity of pump discharge water and subsequent erosion of upland areas. These structures are essential in preventing the flow of turbid water overland and back into the stream - such overflow effectively defeats the purpose of the flumed crossing by introducing turbid water into the stream. To prevent erosion, dewater structures are to be utilized even where silt bags are installed on the end of discharge hoses.

Runoff control structures are utilized to prevent runoff from the spoil piles or from drainage of water from the trackhoe bucket from flowing around the sandbag/plastic dams or temporary equipment crossing bridges and adding sediment to the stream. Containment and control materials are necessary to respond to any spills of fuel or lubricating oils from operating equipment. An SPCC Plan, provided in Appendix E, will be implemented by the contractor in accordance with the provisions of that plan. Erosion control structures address the prevention of runoff from the right-of-way into the stream during and after construction is complete.

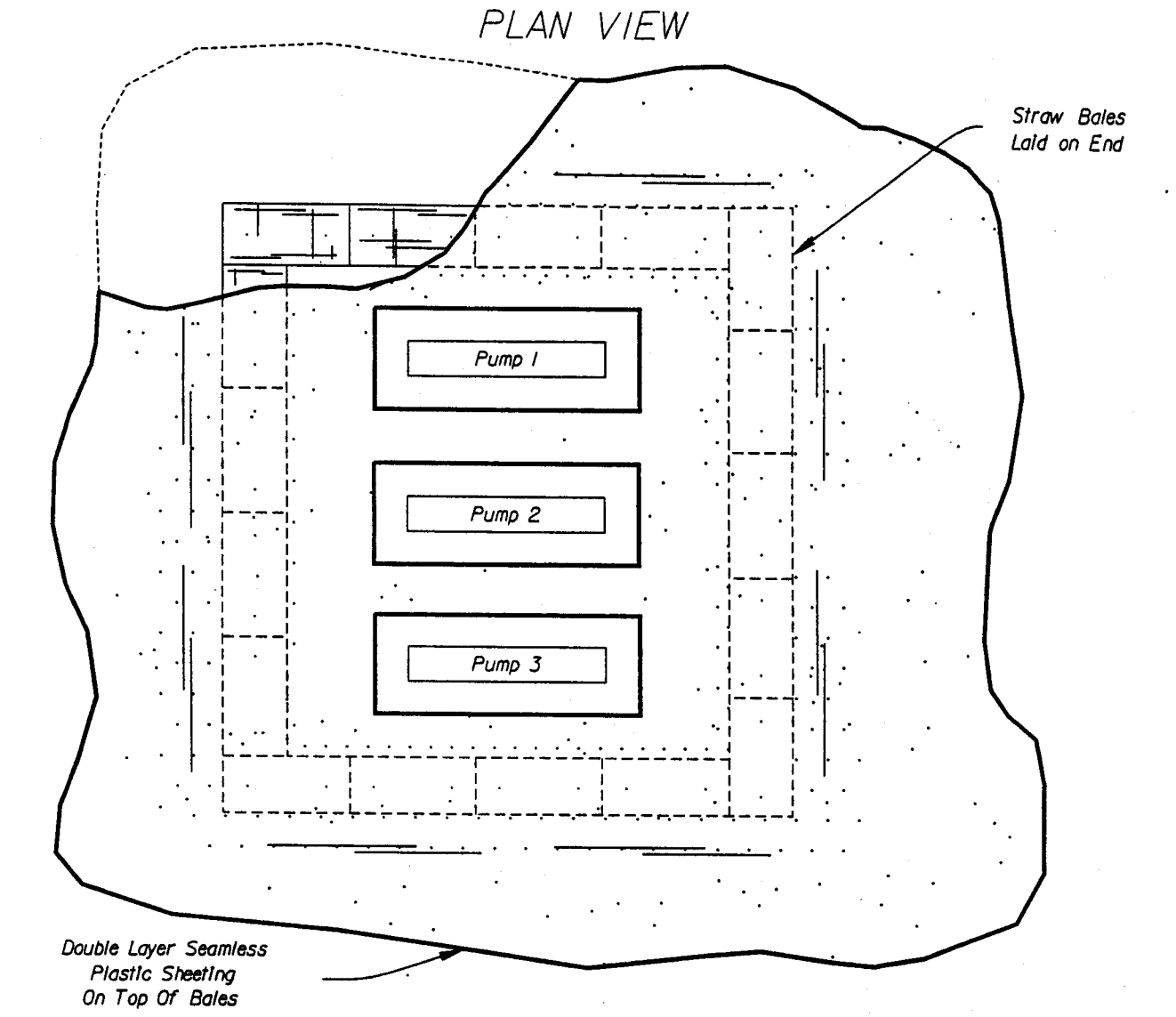
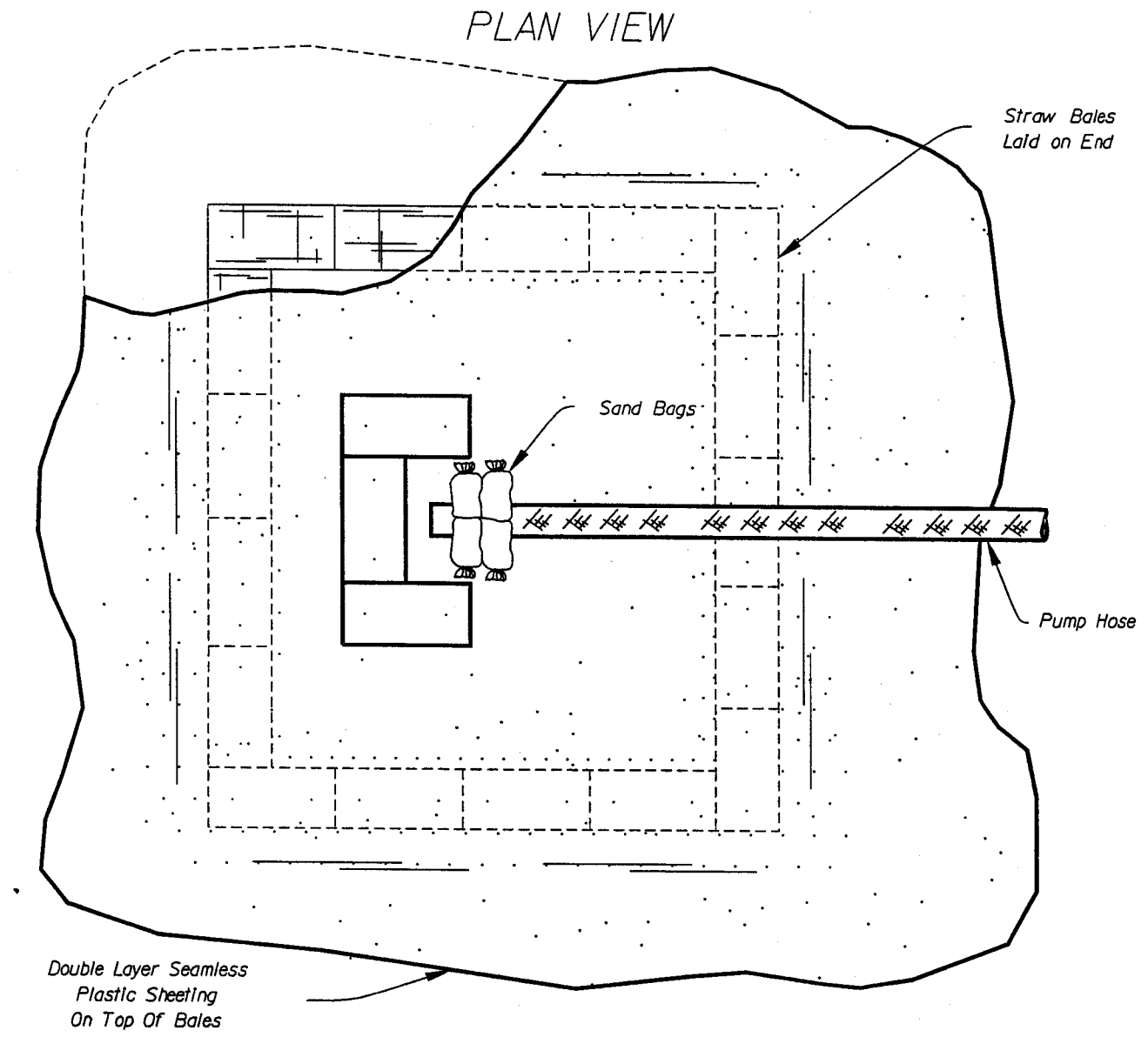


FIGURE 2
TYPICAL PUMP CONTAINMENT STRUCTURE



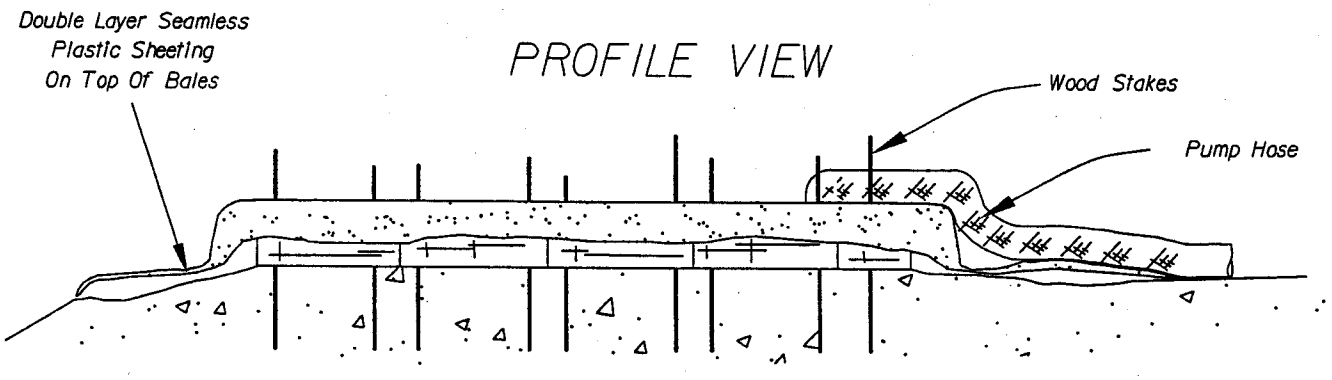


FIGURE 3
TYPICAL DEWATER STRUCTURE

4.0 Materials Required to Install and Maintain a Flumed Stream Crossing

The materials discussed below will accommodate most stream crossings. However, certain situations will arise where additional materials are required. Those streams that require additional materials will be addressed on a case-by-case basis.

Typically, scrap steel pipe will be utilized to construct the flume. Before the flume pipe is installed in the stream, it will be inspected to assure that it is free of grease, oil or other pollutants. In addition, excessive dirt will be removed from the flume pipe. If oil or grease is present on the flume pipe, it will be steam-cleaned before the flume pipe is placed in the stream.

Both the inlet and outlet of the flume pipe will be sandbagged and lined with plastic to create a proper seal (see Figure 4). The reason for sandbagging the downstream end of the flume is to create a contained area where turbid water is trapped and to prevent downstream water from flowing up the streambed and flooding the trench.

Sandbags will be filled with a non-leachable material such as clean, pre-washed sand. Sandbags are most effective if they are only filled to approximately 2/3 their capacity. Bags filled to capacity conform poorly to the adjacent bags and make creation of a seal more difficult. The bags must be tied securely before they are installed. If the bags are left un-tied, they tend to spill upon removal from the streambed and are nearly impossible to remove with a trackhoe. It is preferable to utilize burlap sandbags to construct the upstream and downstream dams. Plastic bags tend to rip when removed from the stream and are often too porous to adequately contain small grain sand.

Sandbags alone are not sufficient to completely seal the upstream and downstream ends of the flume pipes. The dams are only effective when sheets of thick plastic are interwoven within the sandbags (see Figure 5). The plastic, when applied as shown on Figure 5, will effectively seal the dams and will greatly reduce the amount of water leaking into the construction area from behind the upstream and downstream sandbag dam.

5.0 Flume Pipe Design

A number of flume pipe designs have been tried with varying degrees of success. The most effective flume pipes incorporate wings welded to the front end of the pipe that provide for better conveyance of stream flow into the mouth of the flume (see Figure 6). The most effective wings extend to each stream bank and are angled slightly upstream. Where the bottom of the stream is other than rock, the wings extend approximately 12 inches below the bottom of the flume pipe and are pushed into the stream substrate utilizing a trackhoe during installation. The upstream and downstream portions of the wings are then sandbagged and overlain with plastic to prevent leaks as shown in Figure 7.

The flume pipe(s) installed at the crossing will be of sufficient length so that the integrity of the upstream and downstream sandbag dams are not jeopardized by excessive top of ditch widths within the stream or adjacent stream banks. FERC regulations require that the right-of-way through the stream channel and adjacent banks not exceed 75 feet in width. It is tempting to restrict the flumed width to an area smaller than the actual construction right-of-way. However, experience has shown that the contractor often needs to utilize the majority of the 75-foot wide construction right-of-way to complete the crossing. Therefore, the flume pipes must be long enough to span the entire 75-foot wide construction right-of-way through the stream (see Figure 4).

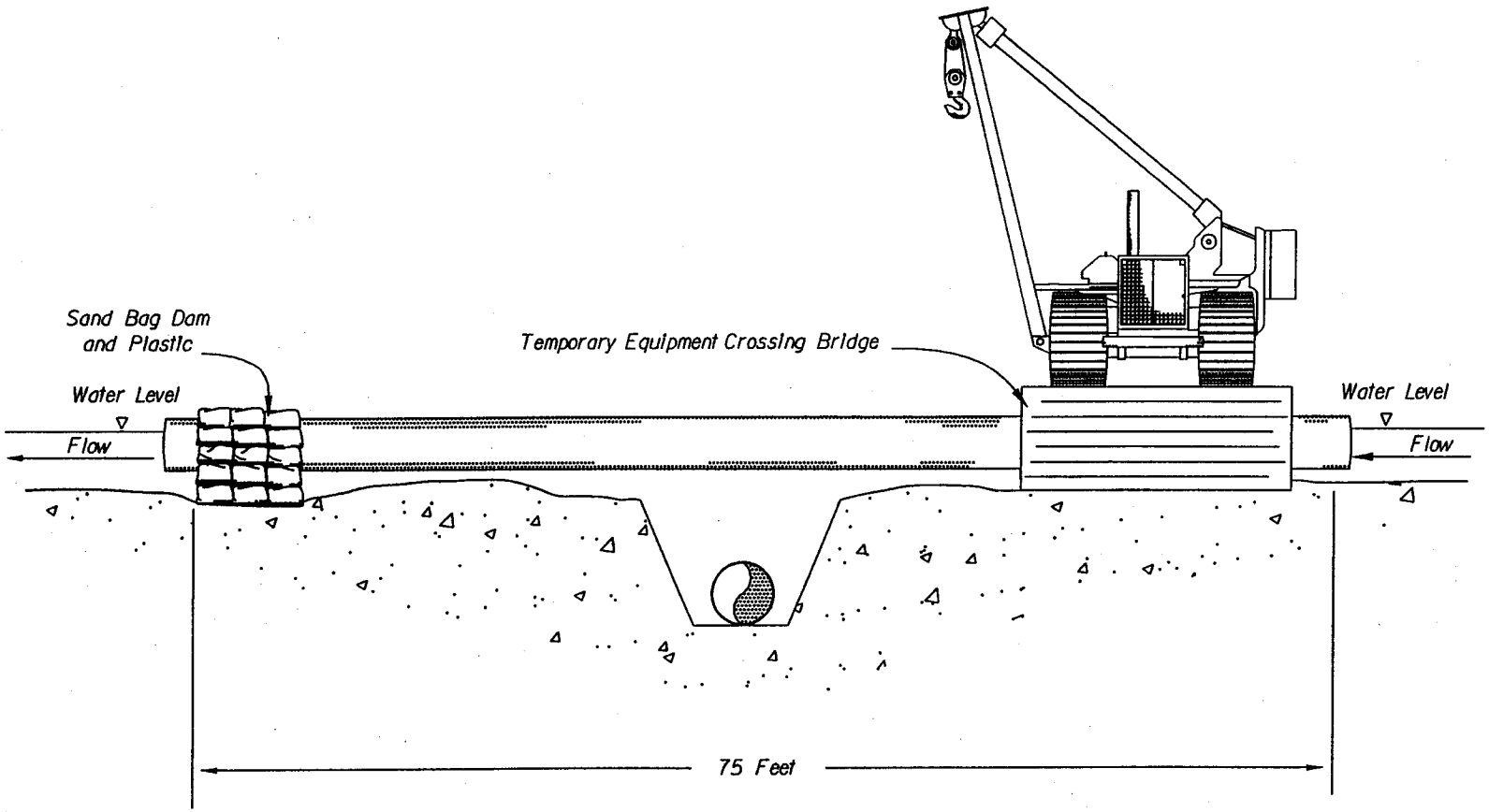


FIGURE 4
FLUME PIPE PLACEMENT ACROSS RIGHT-OF-WAY

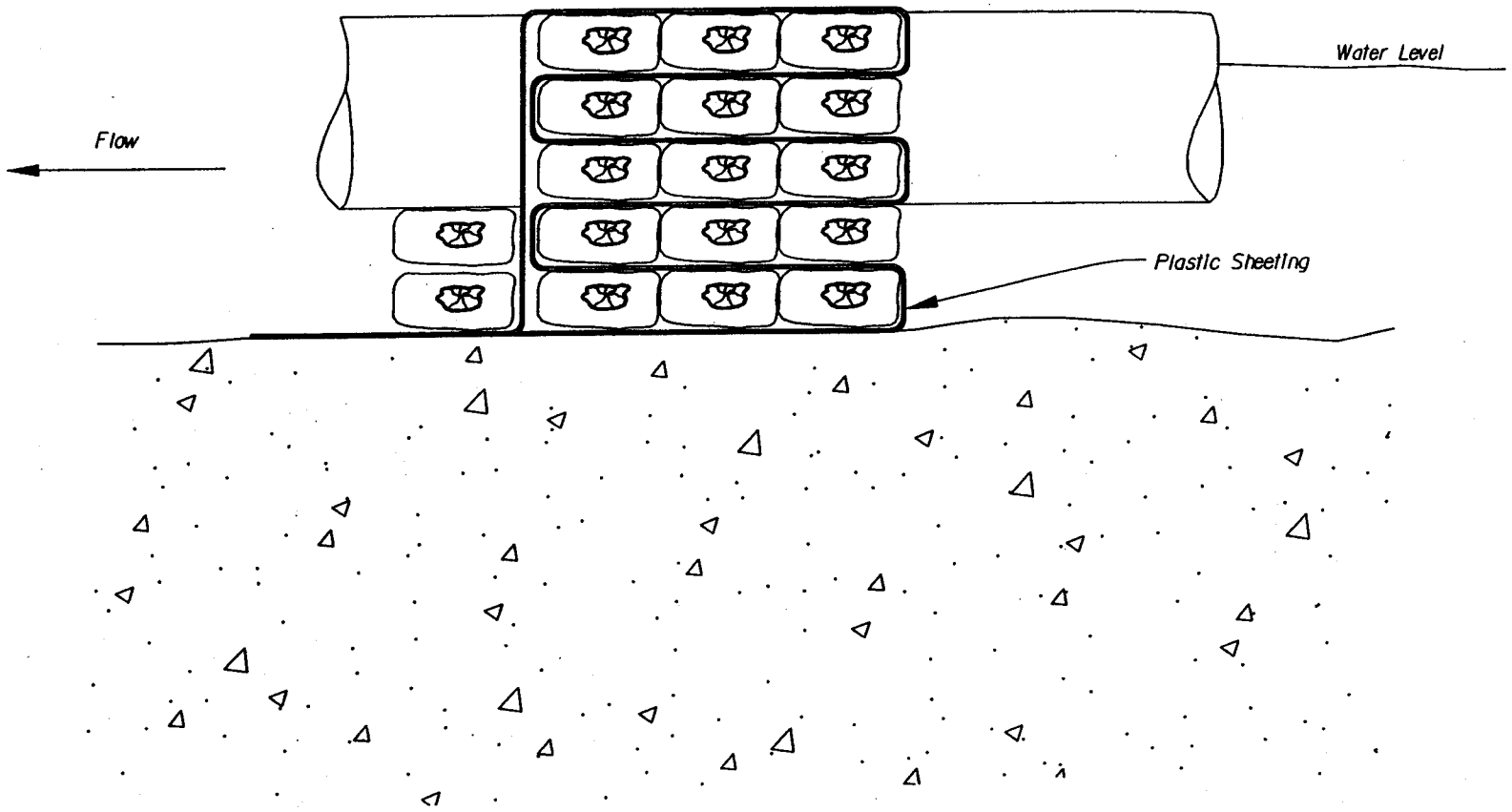
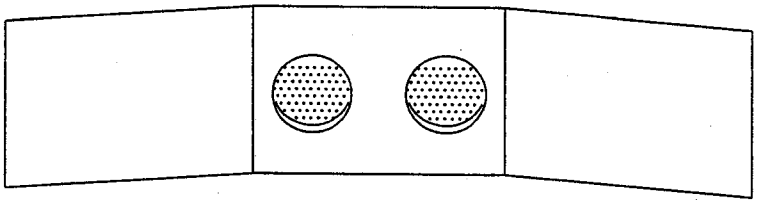


FIGURE 5
PLASTIC SHEETING INTERWOVEN INTO A SAND BAG DAM

FRONT VIEW



TOP VIEW

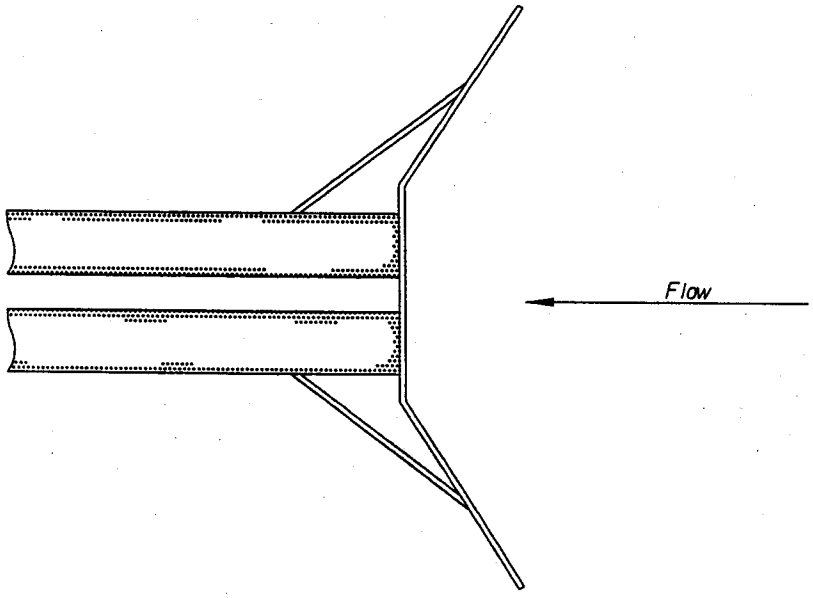


FIGURE 6
UPSTREAM FLUME WINGS

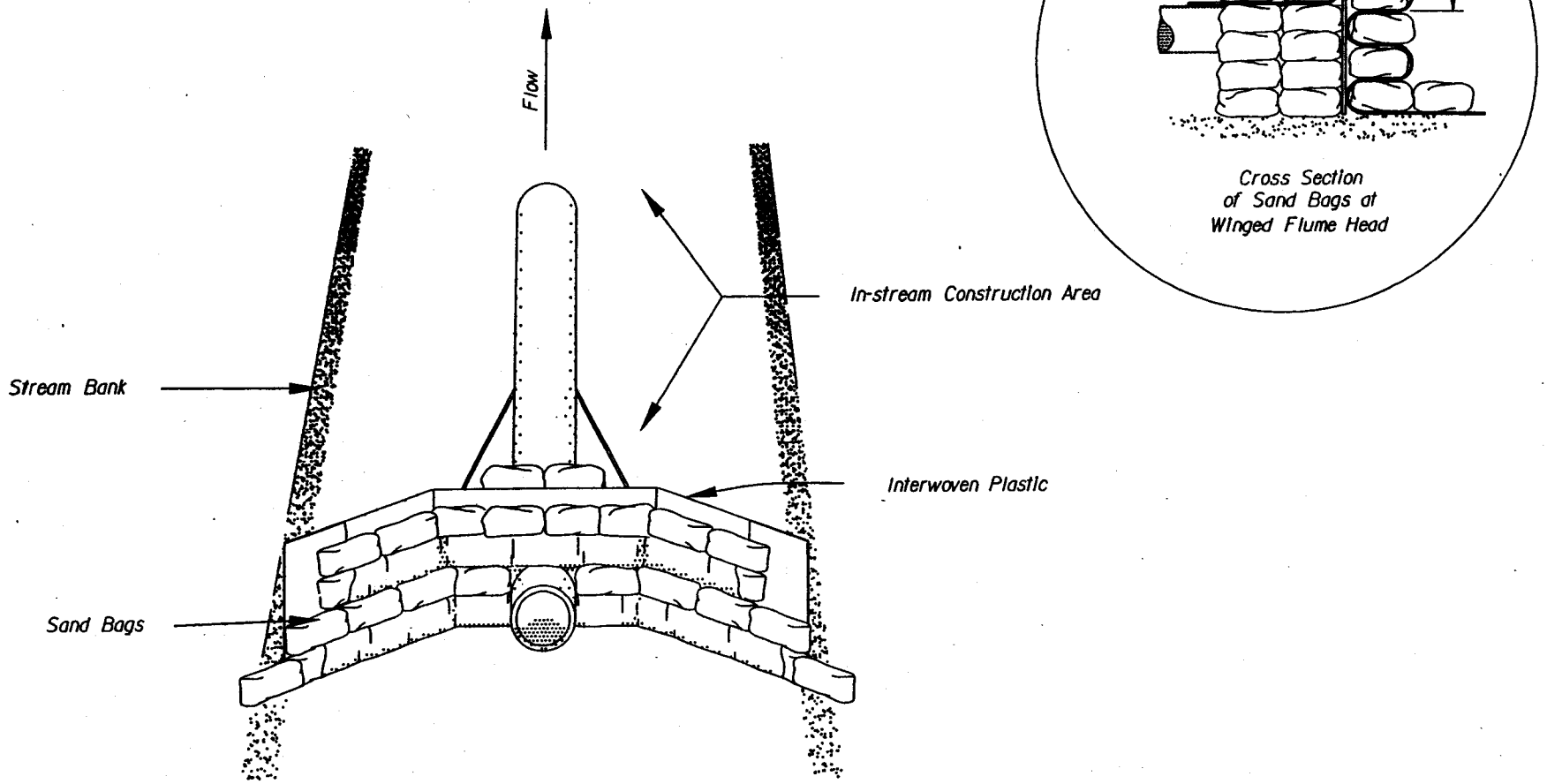


FIGURE 7
SAND BAG AND PLASTIC DAM

As a general rule, a flume pipe of at least 80 feet in length will be utilized for crossings associated with the Everett Delta Lateral Project. The diameter of the flume pipe (s) will depend on the stream discharge at the time of the crossing. However, in all cases the flume pipe diameter will be oversized to accommodate any storm events that might occur during the crossing period.

6.0 Installation of the Flume Pipe

Short-term elevated levels of turbidity are expected to occur during installation of the flume pipe. However, several measures can be taken to minimize the increased turbidity. Before the contractor attempts to install the flume pipe, all materials necessary to complete the installation process will be located on-site. The installation steps are slightly different depending on whether a clean gravel temporary equipment crossing bridge is to be installed. However, under either scenario, installation of the flume cannot begin until all of the precautions outlined in the SPCC Plan (see Appendix E) have been undertaken. Turbidity sampling will be conducted during all flumed crossings in accordance with the Stormwater Pollution Prevention Plan.

Installing the Flume Utilizing Only Sandbag/Plastic Dams

The first step in installing the flume pipe is to clear away from the sandbag/plastic dam area and under the flume pipe any large rocks and boulders that will prohibit placement of the flume pipe or affect the integrity of the sandbag/plastic dam. It may be necessary to utilize a trackhoe to assist in removing these rocks. However, under no circumstances will the bucket be allowed to dig into the streambed to remove rocks. Rather, the edge of the bucket should be utilized to roll the rocks to the side.

Before the flume pipe is installed, the contractor will lay at least three rows of sandbags on the streambed (at least two sandbag layers tall) to support the upstream and downstream portions of the flume pipe (see Figure 5). The sandbags will be laid on top of the plastic sheeting that will be used to help seal the sandbag dam. The plastic will be laid such that when it is wrapped around the sandbag dam, the plastic sheeting lays on the upstream face of the dam so that water pressure holds the plastic firmly against the sandbag dam face. The sandbags will be properly seated over the plastic and onto the stream bottom and packed as tightly together as possible.

Once the first rows of sandbags are in place, the flume pipe can be lowered into position. The flume pipe will be lifted over the stream and carefully aligned before it is lowered onto the sandbags over the streambed. The contractor will not push or pull the flume pipe over the stream banks and into the water. Rather, the flume pipe will be suspended over the crossing and lowered into place.

After the flume pipe is laid on the sandbags, the contractor will begin to construct the upstream sandbag/plastic dam. First, the winged upstream portion of the flume pipe will be pushed into the streambed substrate, where possible. Sandbags will be installed upstream and downstream of the wings and interwoven with plastic sheeting to form a tight seal. Typically, the sandbag/plastic dam will extend at least three feet above the water level of the stream to accommodate increased stream discharge during the crossing period (see Figure 7).

After the upstream sandbag/plastic dam is complete, the contractor will immediately begin installation of the downstream dam. The downstream sandbag/plastic dam will be constructed to a height at least three feet above the downstream water level.

Installing the Flume Using a Clean Gravel Temporary Equipment Crossing Bridge

The same general steps outlined above will be followed for installing a flume with a clean gravel temporary equipment crossing bridge. The flume pipe is still supported on both ends by a row of sandbags. However, after the flume pipe is aligned on the sandbags, either end of the flume pipe can be overlain with clean gravel. The plastic is then wrapped over the upstream face of the clean gravel to provide an effective seal.

The gravel must be placed over the flume pipe and onto the plastic sheeting very slowly to avoid downstream water quality impacts. Dumping gravel into the stream will not occur. Only clean gravel will be used for construction of the temporary equipment crossing bridge. Clean gravel means gravel that has been washed by the quarry and which is free of fines and dirt. It is very important that the contractor inspect the gravel that will be utilized before it is delivered to the site. If the gravel is not clean, it will be rejected by the EI and the contractor will be required to utilize alternative material.

At some of the flumed crossings associated with this project, the contractor will be required to install clean gravel over the top one foot of the trench to provide spawning habitat for fishes. The exact size of the gravel to be installed over the ditch will be specified in the appropriate state permits. The contractor may choose to select a gravel size that can be utilized to provide this spawning habitat when constructing the crossing bridge. If the gravel is too large or small, the contractor will be required to remove the material from the streambed for disposal. If the gravel is of a size that can provide spawning habitat, the gravel from the bridge can be spread over the crossing area thereby eliminating the need for disposal of the bridge material.

7.0 Maintenance of the Flume During Construction

Experience has shown that flumed crossings require constant monitoring and occasional repair during the crossing process. The longer the flume remains in the water, the greater the probability that the dams will begin to leak and that water will invade the construction area in significant quantities. Therefore, it is imperative that once trenching within the stream begins that the construction process is carried to completion non-stop. Typically, this involves installing the flume on the day immediately proceeding construction of the crossing. Ditching of the stream channel should begin early the following morning and the pipe pulled under the flume pipe immediately following completion of the trench. Backfilling should commence immediately following the stringing of the drag section. Except for very difficult crossings, trenching, installing the pipe, and backfilling the trench should be completed in one day.

While the flume is in place, the contractor needs to provide a sufficient crew that will be responsible solely for maintaining the flumed crossing. That crew will apply additional plastic to the dams and add additional sandbags as necessary. In addition, this crew will be responsible for operating the pumps and maintaining the discharge structures. When the crossing is complete, this crew will immediately install the erosion control structures pursuant to FERC's Procedures.

To be adequately prepared to repair the flume, the contractor must have on-site rolls of thick plastic sheeting and extra filled and tied sandbags. These materials need to be stored directly adjacent to the stream crossing so that they are readily accessible should the need to repair the flume arise.

8.0 Length of the Drag Section

One of the biggest problems encountered during construction of flumed stream crossings is the desire to install extremely long drag sections across the stream in a single drag section. The extra length requires that the flume be in place longer than necessary which increases the probability of serious problems with the integrity of the sandbag/plastic dams. In addition, the extra time required to dig additional ditch to accommodate long drag sections can result in integrity problems with the flume dams.

Segments must be kept short and extend only the distance necessary to allow for later tie-in to the upland portions of the pipeline. On most streams only three joints of pipe (only long enough to incorporate the sag bends) should be pulled under the flume. In other locations, it may be necessary to install additional pipe to complete the crossing. This is likely the case at Catherine Creek.

The entire drag section must be made up prior to the start of in-stream trenching. If the drag section is complete (welds x-rayed and joints taped), the drag section can be installed immediately following trenching.

9.0 Trenching Under the Flume Pipes

At some point prior to initiating trenching, chains should be hung from the flume pipe over the ditch line. These chains will be utilized to hang the pump heads or intake pipe into the ditch.

Digging the ditch under the flume requires careful preparation and execution. Two trackhoes will begin trenching from each stream bank at the same time. The trackhoes will begin by trenching under the flume pipe(s) and dig back to the stream banks. Finally, the trackhoes will dig the upland portion of the ditch necessary to install the drag section.

Generally, pumping water from the construction area is not necessary during trenching as the amount of spoil removed from the streambed generally exceeds the volume of water that infiltrates the construction area. However, at times the water flow into the construction area becomes excessive and pumping is necessary to avoid overflow or leakage from the downstream dam.

10.0 Spoil Storage During Trenching

Spoil must be stored in a manner such that runoff from the spoil does not flow into the stream or off the right-of-way. For streams in flat topography, runoff from the spoil storage pile is not typically a problem. However, on steep sloping stream banks water can run back down the right-of-way and enter the stream upstream or downstream of the dams creating a serious water quality problem. The problem can be compounded as the trackhoes working on the stream banks lift water saturated spoil from the stream and lay it on the right-of-way adjacent to the stream bank before it can be conveyed uphill by additional equipment. To accomplish runoff control during trenching, diversion structures or trenches will be dug within the right-of-way to direct the runoff back into the construction area as shown on Figure 8.

11.0 Spoil Transfer During Construction

Some of the stream crossings may occur adjacent to steep upland areas. In these cases, it will be necessary to utilize additional equipment (trackhoes, dozers, cranes) to transfer spoil dug by the trackhoes at each stream bank to the temporary spoil storage area.

In most cases, the contractor will utilize dozers to push the spoil to the temporary storage area. In other areas, trackhoes will be required to transfer spoil dug by the trackhoe working on the stream bank uphill to a flatter area where it can be moved by dozers. Where two trackhoes are utilized to transfer spoil uphill, it is often desirable to have the trackhoe working on the stream bank place the spoil into a pit (see Figure 9). The spoil from the pit is then picked up by the second trackhoe and lifted further uphill. The pit will significantly reduce the amount of water from the spoil that runs downhill. The pit can be maintained and dug by the trackhoe working uphill from the crossing.

12.0 Installing the Pipe

While trenching is being conducted, the contractor will hook up the drag section to the sideboom tractors so that the pipe may be installed as soon as trenching is completed. It will be necessary at many crossings to float the pipe across the trench (i.e., it may not be feasible to completely dewater the ditch). While the drag section is being slid under the flume pipe, it is essential that pumps be operated to assure that turbid water does not leak through or flow over the dams. The contractor will operate the pumps at a rate so that water displaced by the pipe is immediately removed and discharged to the dewater site.

13.0 Dewatering the Construction Area

Proper operation of pumps is essential to the successful completion of a flumed stream crossing. Pumps will be utilized by the contractor as necessary to control the level of water in the construction area. The purpose of the pumps is not to completely dewater the trench. Rather, the pumps are used to keep the water level in the flumed construction area slightly below the level upstream and downstream of the dams. As long as the water level in the construction area is less than the level outside of the construction area, water will continue to leak slowly into the construction area.

Should the water level in the construction area exceed the level upstream or downstream of the dams, the contractor will notice small amounts of turbid water escaping into the stream either upstream or downstream of the dams. This is known as "bleeding" and the problem can be quickly resolved by increasing the pumping rate and reducing the water level within the construction area. Although bleeding will not typically result in a violation of water quality standards downstream, if left unchecked it can quickly result in erosion of the dams and serious downstream water quality problems.

The contractor will utilize pumps at each crossing to control the water level in the construction area. The contractor will also install a backup pump that will be tested and fully functional prior to the start of the crossing process. Pumps will be installed and tested and the dewater sites constructed the day prior to any in-stream construction.

For most crossings, the contractor will setup three pumps. Additional pumps may be required at a few of the stream crossings. Two of the pumps will serve to remove water from the construction area and the third pump will serve as a backup should one of the primary pumps fail.

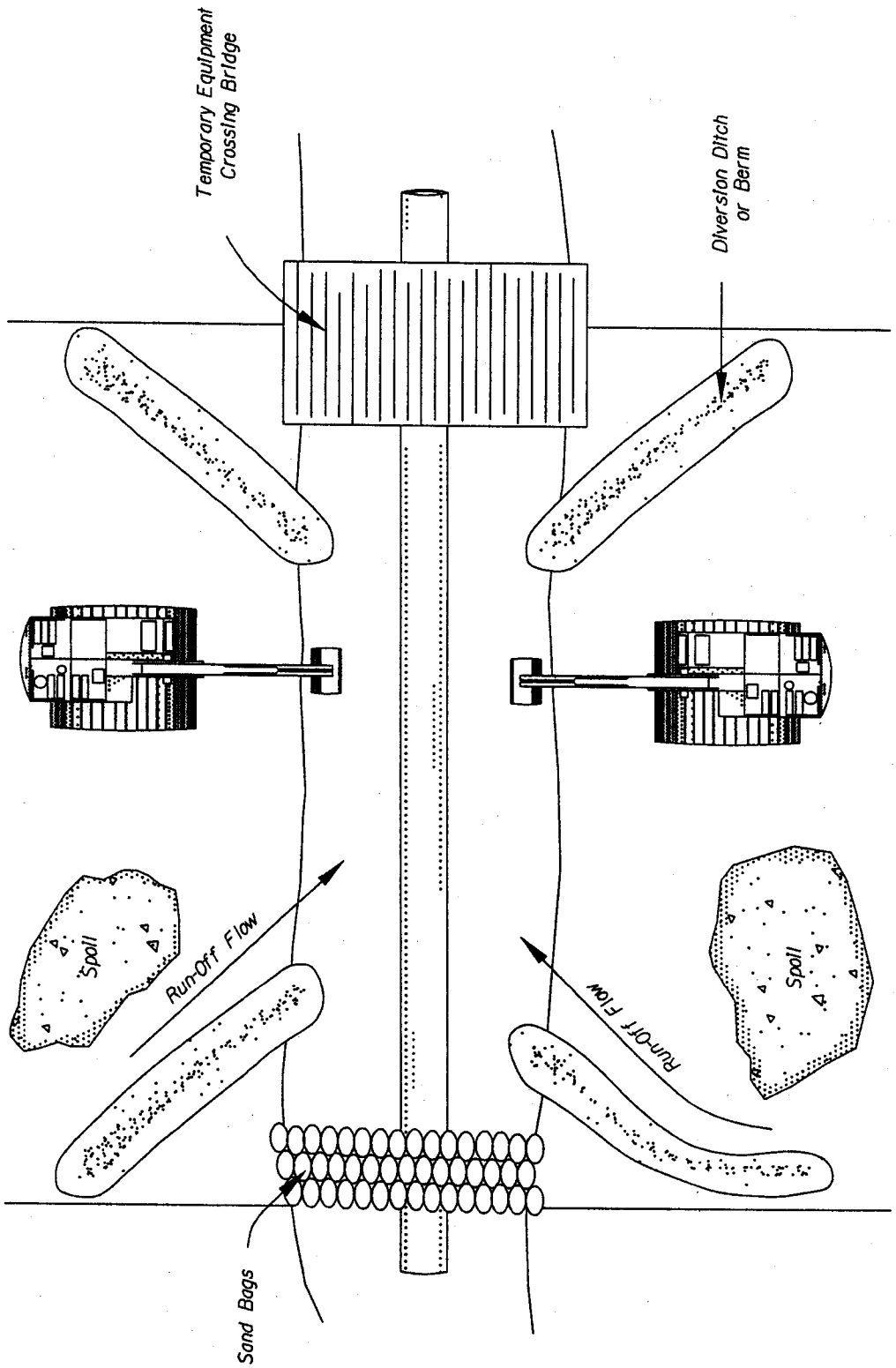


FIGURE 8
DIVERSION DITCH OR BERMS

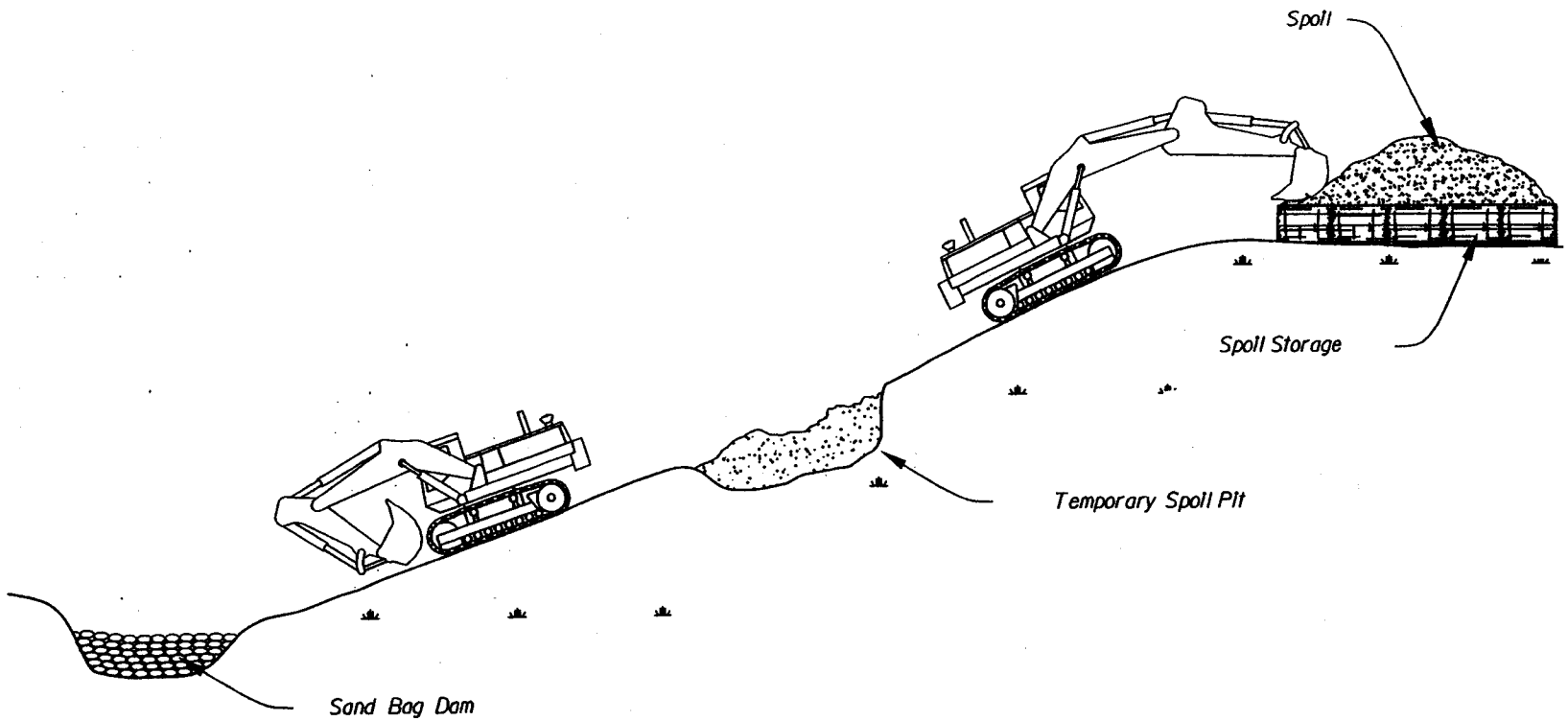


FIGURE 9
UPHILL SPOIL TRANSFER

The pumps will be set in a containment area as shown on Figure 2. The primary purpose of the containment area is to fully contain any fuel or lubricating oil spills. If hydraulic pumps are used, the hose couplings on the side of the pump body will be oriented in the containment area such that they point perpendicularly away from the stream banks. The purpose of orienting the couplings away from the stream is to protect the stream should one of these couples fail and hydraulic fluid escape.

The contractor will carefully inspect each pump prior to its delivery to the crossing site. In particular, any frayed hoses or apparent leaks will be repaired before the pumps are delivered to the crossing site. Pump heads and the hoses will be cleaned of any free hydraulic oil prior to placing the pump heads into the stream. No visible sheen of oil should be evident from pump equipment placed in the stream.

All three pumps will be installed with individual intake hoses or hydraulic heads, trash filters and discharge hoses. All three hydraulic heads will remain in the water during the entire construction process including backfill. In this manner, the backup pump can be immediately employed should one of the primary pumps fail.

Each of the pumps (including the backup pump) will be equipped with a minimum of 300 feet of discharge hose. It is important to stretch the hose on the backup pump and install a dewater structure for that pump at the same time the primary pumps are installed. Hoses should be free of leaks and in good operating condition.

In many cases, it is difficult to locate dewater sites where water will flow away from wetlands or streams. In these cases, careful attention will be paid to the dewater sites and alternative sites (which require additional discharge hose) selected prior to the start of in-stream construction. Often it is necessary to move the location of the dewater site several times during construction of the stream crossing to avoid dewater from reaching sensitive areas.

Dewater structures will be constructed of straw bales and plastic and wooden stakes as shown on Figure 3. The intent of the design provided on Figure 3 is to allow the water to fill the dewater structure and flow evenly over the tops of the bales. Straw bales will be securely staked to the ground utilizing wooden stakes.

14.0 Backfilling the Ditch

The highest potential for causing water quality problems during a flumed crossing is during backfilling of the ditch. Often the contractor will attempt to backfill the ditch too quickly, which will cause the water level in the construction area to overflow or leak through the downstream dam. Pumps must be carefully utilized during backfilling to control the water level in the construction area. The contractor must carefully monitor the effectiveness of the pumps and control the rate of backfill to preclude bleeding through the downstream dam. If backfilling occurs too quickly, the pumps will not be capable of removing the water from the construction area quick enough to prevent the escape of turbid water.

To prevent turbidity, backfilling of the ditch will be conducted in a slow, well-planned manner. Backfilling will begin in the center of the stream directly under the flume pipes and proceed toward each bank simultaneously. In this manner, much of the water in the ditch will be pushed to the ditch outside of the stream channel. If upland portions of the trench are backfilled first, the water in the ditch is pushed into the stream channel and will inevitably leak through or overflow the downstream dam.

Once backfilling of the entire stream channel is complete, the contractor will compact the streambed and construct solid plugs on both banks. Water will remain trapped in the ditch outside of the stream channel. This water will be pumped from the ditch at a later time in the manner described for dewatering the construction area (see Section 13).

15.0 Flume Removal

After the ditch is backfilled, the clean gravel fill placed on the top one foot of the ditch (where necessary), plugs installed at each stream bank and the stream banks stabilized, the flume must be removed from the crossing. The techniques utilized to remove the flume will depend on whether a clean gravel temporary equipment crossing bridge has been installed or whether sandbag/plastic dams were utilized on both ends of the flume.

Removing the Flume with Sandbag/Plastic Dams on Both Ends

To prevent excessive increases in turbidity during flume removal, the contractor will first carefully remove all of the sandbags from the downstream dam. A trackhoe can be utilized to remove the top layers of the sandbags as long as the operator takes great care not to dig into the streambed or to increase turbidity.

After the downstream sandbags are completely removed from the streambed (except those few left directly under the flume), the contractor will begin removing the sandbags from the upstream dam. The top rows of sandbags should be removed by hand until the water begins to overflow the top of the dam and flows slowly over the construction area. For the first 10 to 30 minutes, turbidity downstream of the crossing area will increase significantly. However, very quickly the streambed portion of the construction area will be flushed clean of sediments left over from construction and the water will again flow clear over the construction area. After the turbidity level has decreased, the contractor can proceed with removing the remainder of the upstream dam sandbags.

Once all of the sandbags are removed, the flume pipe should be removed. The flume pipe will be raised directly from the streambed in a single movement. Under no circumstances will the contractor drag the flume pipe from the streambed. Rather, it will be lifted and then carried from the crossing area. After the flume is removed, the remaining few sandbags, which were laid directly under the flume pipe, can be removed by hand.

Removing the Flume with a Clean Gravel Temporary Equipment Crossing Bridge on One End of the Flume

The process of removing the flume where a temporary equipment crossing bridge has been installed is similar to that discussed above. If the temporary equipment crossing bridge is located at the downstream end of the flume pipe, the gravel can be removed from the flume pipe using a trackhoe. If the gravel meets the specifications of the state permits for spawning gravel, then the gravel removed from the bridge can be spread over the bottom of the construction area. If the gravel is too large, it must be removed from the streambed and disposed of. After the downstream gravel bridge is removed, the upstream bridge will be removed in the same manner as described above.

If the temporary equipment crossing bridge is located at the upstream end of the flume pipe, the downstream sandbag/plastic dam must be dismantled first. The gravel from the bridge is then removed with a trackhoe and spread very carefully over the construction area. Once the flume pipe is removed, all in-stream construction work is complete unless rip rap is required where the dam is installed.